Fall 2020
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PHYSICS FLASH

INSIDE

Los Alamos NATIONAL LABORATORY EST.1943

> “My role at the Laboratory is to help provide the experimental underwriting so that our nuclear weapons retain their effectiveness, thus maintaining their role as a deterrent to global war.

Patrick Younk

Fusing concepts, technology to predict performance of nuclear explosive devices

Patrick Younk understands the rewards of hard work. Younk grew up in Michigan's Upper Peninsula, an environment lined with forests and dotted with waterfalls. His first occupation was as a logger, working with his father. The job was tough and satisfying, but by the time he turned 15 he had another profession in mind.

“I remember when my high school counselor asked me what I wanted to be when I grew up,” Younk said. “Without hesitation, I answered ‘engineer.’ ” After college, Younk spent eight years as such in the printing industry, receiving patents for his novel system designs.

Eager for new challenges, he returned to school and earned a PhD in physics from Michigan Technological University. His ultra-high-energy cosmic ray research eventually led him to join Neutron Science and Technology (P-23). On Brenda Dingus's astrophysics team, Younk helped create components for HAWC, a high-altitude water Cherenkov gamma ray observatory located on the slopes of a 13,500-foot volcano in Mexico. One of his proudest contributions, he said, was discovering

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Tanja

From Tanja's desk . . .

Dear all,

Since we discussed (and will continue to do so) division strategy and structure in a recent all-hands (October 5), I will focus this column on a different topic. My one-year anniversary in P Division is approaching—hard to believe an entire year has passed! That makes me think about my first days in the division, and there is one conversation that I remember vividly. One of our staff members told me that they had asked David Meyerhofer how he was spending his days. His response was a smile, and he said "I attend a lot of meetings." I also remember the staff member telling me the story was a little disappointing—apparently they had thought that a DL does grander things! For that reason, I thought it might be nice if I share what I do on a daily basis and elaborate on David's response—and yes, there are a lot of meetings!!!

I see myself first and foremost as THE advocate for our division and our staff, and that means I need to know everything that is going on (well, as close to "everything" as I can get). I have my calendar organized on a biweekly cycle. I alternate "line" with "program" weeks, where some of those interactions happen only every fourth week. Every two weeks, Eric and I meet with all our group leaders and deputy group leaders, by group. They update us on science advances, funding, personnel, and operational issues. Other topics are added on an as-needed basis, be it LDRD season, promotion season, or special requests from various places in the Lab.

Similarly, I meet every four weeks with our key program managers—Ray Tolar/Brian Albright (C1), Dana Dattelbaum (C2), Bob Reinovsky (C3), and John Kline (ICF and FES), as well as Joe Carlson (NP), Rajan Gupta (HEP), and Bill Priedhorsky (LDRD). I frequently talk to Jonathan Morgan and Frank Merrill (hydros), although we don't have a regular meeting set up. I also have regular monthly meetings with Kim Scott (OES) and Mike Hundley (SC), and with Don Haynes (Nevada) on an as-needed basis. Of course, with Russ Olson in his new role as Nevada Weapons Experiments program manager, I will add him to the list. Mike Furlanetto and I have a regular meeting (in addition to the "7:40" meetings and the LANSCE Council meetings) where we discuss P/LANSCE-specific issues. I also regularly engage with fellow division leaders Brian Lansrud-Lopez (XTD), Mark Schraad (XCP), Jay Carnes (E), Chuck Mielke (M), and Marianne Francois (T), as well as my DL colleagues from ALDPS (AOT, MST, MPA, Sigma, and LANSCE-FO). With the program managers and program directors, the conversations focus on intersections of line and program. They update me on progress and share needs, concerns, and recommendations and we strategize jointly. The interactions with my fellow DLs are both operationally and strategically focused. I have honest and trusting relationships with all my colleagues that I greatly value.

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From Tanja's desk cont.

In addition, I have regular meetings with Kathy Prestridge on pRad and Tom Venhaus on Pu@pRad, and we still run our biweekly pRad Executive Council (a result of the January pRad mini-retreat) where we ensure cross-organizational communication with Wendy Vogan-McNeil (M-3), Guillermo Terrones (XTD-SS), Shawn McGrane (M-9), and Joe Dabney and Logan Robinson from LANSCE-FO.

I attend our weekly ALDPS Council meetings, and I have biweekly one-on-ones with Toni to pass information, recommendations, needs, and concerns up the chain. Similarly, our Physics Division Management Team has a standing weekly council meeting (that now also includes Jackie Mirabal-Martinez as the division's safety and compliance coordinator) where we focus on intra-divisional communication and discussion, as well as our P Division strategy. Safety, security, and operational issues are touched on in a weekly meeting with Jackie.

Like many of you, I serve on LANL committees (I'm on my third search committee this year), and work on other Lab-wide issues such as our pillars, or the Division Leader Council that I have been chairing since August. That position also gets me an invitation to the Leadership Retreats (our Director, Deputy Directors, and ALDs), a wonderful opportunity to learn first-hand about and contribute to how our Laboratory leadership is strategizing for the Lab's future.

Last but not least, I have regular meetings (that's a recent development) with Jeff Paisner as DDW representative on Pu@pRad issues. And, as I have mentioned on occasion, Mark Chadwick (ALDX) has become an informal mentor to me (originally on weapons issues after I first obtained my clearance) and this mentorship has grown to cover broader P/ALDX issues.

In addition, I attend meetings that are owned by other organizations—OES runs the so-called monthly G8 meeting, and I like attending the WWG and WRIG when in session. And of course, we have our P&T Colloquium that I enjoy attending whenever I can. As some of you know, my weekly luxury used to be the WESH (Weapons Engineering Study Hall). This is where I learned a lot about mission-relevant issues, actually way more than in Titans, which is very fast-paced and less interactive (my second semester of Titans fell victim to COVID). Sadly, in the early spring, the WESH lost its meeting room, and then COVID delivered another–and the potential final–blow. I am afraid it will not come back, truly a shame and a loss for LANL.

The remaining space on my calendar gets filled with ad hoc situations, and in particular it is important for Eric and I to have sufficient overlap so we can bring each other up to speed. We work as partners (I am not a fan of the "glamour" and "house chores" type division of labor between DL and DDL). Both of us keep each other informed so that we can seamlessly back up each other and "divide and conquer" when needed.

My absolute favorite time is that spent with our division members. Through the major calendar reorganization I did in the spring I created "white space" on the calendar every day so that I have time to walk around or catch up with individual staff members—sometimes spontaneously, sometimes pre-planned—to discuss an issue or concern. That means if there is anything that excites or burdens you that you would like to share, I can likely make some time available the same day. What I most enjoy is learning about what you all do, what you enjoy, and what you are struggling with. I consider my most successful days those where I remove a hurdle that impedes you from doing what you love. So, do talk to me!

And then of course there is email … our never-ending self-imposed burden; for me typically about 150 messages a day. I try to catch up on those in between meetings or in "white space" time, but often they have to wait until later that night. Those needing elaborate responses or actions often may have to wait for days off and the weekends. As you all know, I also need to sign documents and approve actions. Here is my appeal to you: If you need something and you don't hear back from me within 24 hours, please send me a ping! Sometimes I open an action, begin working on it, get interrupted, and then forget that I did not finish it. That is particularly true for CIO exception requests.

I am tremendously proud and honored to be your division leader and the division leader of Physics. I see Physics at the core of what LANL stands for. I hope you share this pride and will help me make Physics the most coveted place to work for at LANL—the division where the most impactful and interesting work is done, the division where collegiality, inclusion, respect, and collaboration are the norm, and the division that looks with equal pride at its tremendous legacy, current accomplishments, and future impact.

Physics Division Leader Tanja Pietraß ■

Younk cont.

variable gamma ray transmission from an active galaxy, "the very first such observation from a ground-array observatory."

He followed this assignment by working alongside David Holtkamp, conducting plutonium experiments at the Nevada National Security Site. "Working with explosives, high-power lasers, flash x-ray machines, radioactive materials, all while 1000 feet below ground in the Nevada desert," he said, was "totally different."

Now Younk applies his experience and his drive to designing, executing, and analyzing experiments to better understand and predict the performance of nuclear explosive devices. He said his enjoyment comes from the people he works with—and that he works with excellent people.

"My job is a mix of scientist, engineer, and project manager," he explained. "I'm a scientist when I study the high-level problems we are trying to solve, precisely distill what we know and what we do not, and map out a way to fill in knowledge gaps with experimentation. I am an engineer when I work on the practical design of the experiments, reviewing and approving drawings, and working under the necessary rigor of our conduct of operations. I'm a project manager when I manage complex project schedules, million-dollar budgets, and teams made up of technicians, engineers, and scientists."

Younk recently led the primary diagnostic effort on an experiment designed to investigate the B61 nuclear bomb. The new diagnostic—broadband laser ranging—uses laser beams to precisely measure the position of a surface at up to 40 million times per second. Younk earned a 2017 Laboratory Individual Distinguished Performance Award for leading the

In the main control room of the firing site where the broadband laser ranging experiment was fielded are (from left) Ryan Emmitt, Anselmo Garza, and Patrick Younk. The new diagnostic system is at right.

Photo courtesy of Jonathan Morgan, J-DO

implementation of the technique. The project was particularly challenging because the researchers were asked to design, build, and field the diagnostic within a one-year timeframe (Please see "Patrick Younk's favorite experiment," below). The team executed the experiment in January and in February he delivered the preliminary data package to customers in Weapon Physics.

Younk said nuclear weapons serve as a strategic deterrent to protect the United States, its allies, and the planet against another destructive war. "My role at the Laboratory is to help provide the experimental underwriting so that our nuclear weapons retain their effectiveness, thus maintaining their role as a deterrent to global war."

Despite a busy work schedule, Younk finds time to enjoy his winter passion: alpine skiing. He even helps clear the runs of fallen trees. "Remember, I was once a logger," he said. "I find such physical exertion to be very therapeutic."

By Octavio Ramos Jr., CEA-CAS

Patrick Younk's favorite experiment

What: Precise dynamic measurements of position on a B61

Why: Our objective was to experimentally underwrite the B61 Life Extension Program

When: January 2020

Where: Firing Site R306 at TA-15

Who: The following directly supported the fielding of the diagnostic: Brian Cata, Michael Pena, Abel Diaz, Ryan Emmitt, Anselmo Garza, Carlos Perez, and myself. Members from J Division led the fielding of the integrated experiment.

How: In six months, we designed and built 16 diagnostic points of broadband laser ranging. We then brought these points to R306, where we fielded them on the experiment.

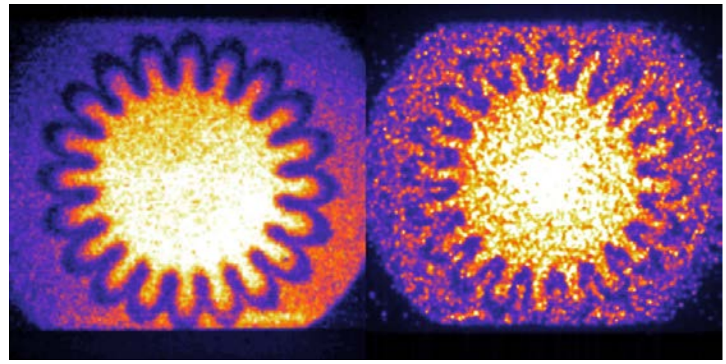
The "a-ha" moment: This was a new diagnostic, and we expected it to deliver both greater quantity and greater precision of data than the previous diagnostic—the key word being "expected." The experiment was underwriting billions of dollars of work associated with the B61 Life Extension Program. We were told, "You are the Primary Diagnostic." Yes, we did feel a little bit of pressure. The a-ha moment took place during the post-shot data-review meeting. It was during this meeting when we realized that indeed the diagnostic performed as expected and compared very well with pre-shot predictions. Even though we knew the data analysis would continue for some time (it is still ongoing), we knew that we had a new and better diagnostic that would supply high-fidelity data for our stockpile stewardship mission now and into the future.

LANL inertial confinement fusion program aims to develop burning plasma for weapons science

Achieving burning plasma has proven difficult, even after nearly a decade of attempts. Various physics and engineering issues are at play, including hydrodynamic instabilities. Hydrodynamic instabilities such as Rayleigh-Taylor (RT) and Richtmyer-Meshkov (RM) instabilities cause significant performance degradation in inertial confinement fusion (ICF) implosions. These instabilities lead to fuel-pusher mix, reduced hot-spot temperature, reduced compression, and lower neutron yield. Imperfections such as surface roughness drive non-uniformity and engineering defects like fill tubes, glue spots, and tents can seed initial perturbations that are subsequently amplified by RT and RM growths, leading to mix and performance degradation of ICF implosions. Understanding such instability growth and ways to mitigate it is vital to achieving ignition in ICF capsules.

Precise measurements of hydrodynamic instability growth are also crucial for validating the underlying physics models in radiation-hydrodynamics codes that are central to ICF experiments. Researchers in Plasma Physics (P-24) with their colleagues have demonstrated nearly identical hydrodynamic instability growth in cylindrical implosions at two different facilities—the larger National Ignition Facility (NIF) at Lawrence Livermore National Laboratory and the smaller Omega Laser Facility at the University of Rochester. The scale-invariant hydrodynamics growth allows study of the underlying physics of NIF implosions at the smaller Omega facility, where 14-16 shots in a day can be obtained—compared to NIF, where one shot a day, which is also more expensive, can be obtained.

The team performed cylindrical implosion experiments both at NIF and Omega to measure the scale-invariant hydrodynamic growth[1, 2, 3]. The NIF cylinder target was three times larger in radial dimension compared to the Omega cylinder, which was roughly 1 mm in diameter. The cylinder had an embedded aluminum marker layer with precisely engineered perturbations (mode 20) enabling the instability growth measurement via x-ray radiography. The NIF implosion also took three times longer compared to the Omega implosion. Despite the different temporal and spatial scales, the team observed nearly identical instability growth at both the facilities. The team plans to increase the convergence (the ratio of the initial fuel radius compared to the fuel radius at stagnation) of the implosions to 10-15 from the current convergence of 2.5 by replacing the foam core with low-density gas



X-ray radiograph of cylindrical implosion at the Omega Laser Facility (left) and the National Ignition Facility (right). The team observed nearly identical instability growth, despite different temporal and spatial scales, at both facilities.

fill. Measurements at high convergence will provide instability measurements that are directly relevant to ignition-scale implosions.

Researchers include Sasi Palaniyappan (Plasma Physics, P-24), Joshua Sauppe (Plasma Theory and Applications, XCP-6), Kirk Flippo (P-24), Benjamin Tobias (Neutron Science and Technology, P-23), and John Kline (Associate Laboratory Directorate for Weapons Physics, ALDX).

The work, which supports the Laboratory's Stockpile Stewardship mission and Nuclear and Particle Futures science pillar, is funded by the Inertial Confinement Fusion program (LANL Science Campaign 10 Program Manager John Kline).

Technical contact: Sasikumar Palaniyappan

References

1. J. P. Sauppe, et al. "Demonstration of scale-invariant Rayleigh-Taylor instability growth in laser-driven cylindrical implosion experiments," *Phys. Rev. Lett.* 124, 185003 (2020).

2. S. Palaniyappan, et al. "Hydro-scaling of direct-drive cylindrical implosions at the OMEGA and the National Ignition Facility," *Physics of Plasmas* 27(4), 042708 (2020).

3. J. P. Sauppe, et al. "Design of cylindrical implosion experiments to demonstrate scale-invariant Rayleigh-Taylor instability growth," *High Energy Density Physics* 36, 100831 (2020).

Lab's high energy nuclear physics explored at international conference

Research by members of the Subatomic Physics (P-25) High Energy Nuclear Physics team was highlighted at the recent 10th International Conference on Hard and Electromagnetic Probes of High-energy Nuclear Collisions. Team members presented seven invited talks, making it record participation for the team in one of the most important conferences in heavy ion physics, according to Cesar da Silva (P-25).

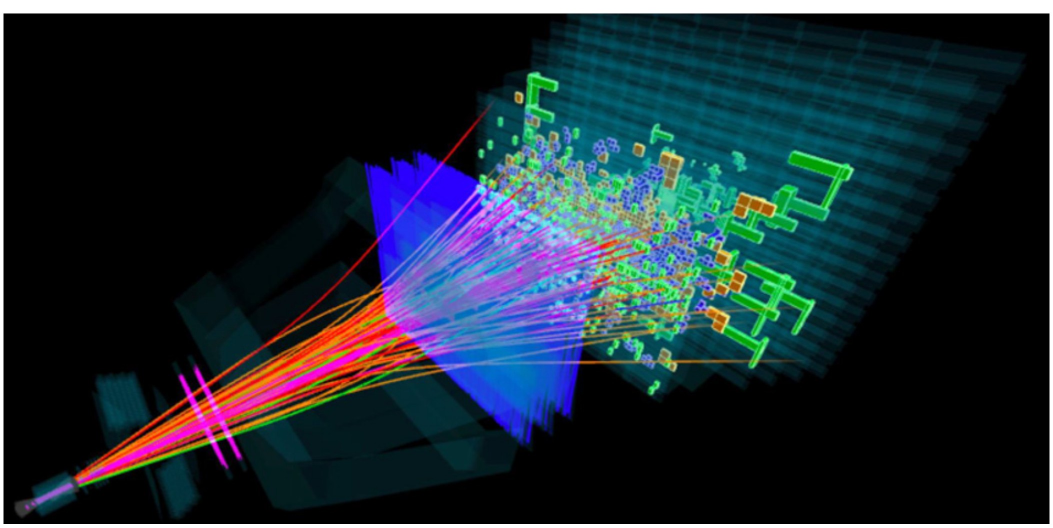
The conference, presented online this year, drew more than 700 attendees from universities, national laboratories, and national institutes and academies of science from around the world. The event focused on experimental and theoretical developments on perturbative probes of hot and dense quantum chromodynamic matter as investigated in high-energy nucleus-nucleus, proton-nucleus, and proton-proton collisions. The local organizing committee included da Silva and Ivan Vitev (Nuclear and Particle Physics, T-2).

Presenting plenary talks were Matt Durham on “Quarkonia: Experiment,” Eliane Epple on “Jets experiment overview,” and da Silva on “LHCb: Recent results and future plans.” Also giving a plenary talk was Matthew Sievert (formerly T-2, now University of Illinois) on “Saturation physics at e-p, e-A and p-A colliders.”

- In “X(3872) production in pp with particle multiplicity,” Cameron Dean presented new measurements by the LHCb (Large Hadron Collider beauty) experiment that, through its precision vertexing, tracking, and particle identification capabilities, shed light on the structure and behavior of the exotic particle X(3872).
- In “New PHENIX results on mid-rapidity bottom and charm production in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV,” Ajeeta Khatiwada presented the latest results, generated using data from the 2014 and 2015 beam runs at the Relativistic Heavy Ion Collider (RHIC), on mid-rapidity bottom and charm production and the implications for understanding the dependence of quark mass on quark energy loss when crossing the quark-gluon plasma.
- In “Exploring potential jet modification in small collision systems with two particle correlations at PHENIX,” Cheuk-Ping Wong presented recent measurements using data generated at RHIC and possible interpretations of jet particle behavior inside the quark-gluon plasma.
- In “Heavy flavor jet studies for the future Electron-Ion Collider,” Xuan Li presented details on a proposed new physics program for the future Electron-Ion Collider to be built in United States. Li presented the LANL ideas on a forward silicon tracking detector and measurements that can answer long-standing questions on nuclear matter density and the origin of the mass.

The conference included three posters presented by team members: “Heavy quark nuclear modification at forward rapidity in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV,” by da Silva, “sPHENIX MAPS prototype test beam results,” by Dean, and “The sPHENIX MAPS-based vertex detector,” by Yasser Morales.

Technical contact: Cesar da Silva



Findings of the nuclear physics program of the LHCb experiment at CERN were featured at the recent 10th International Conference on Hard and Electromagnetic Probes of High-energy Nuclear Collisions. Left, a schematic showing how the experiment detects a lead+lead collision.

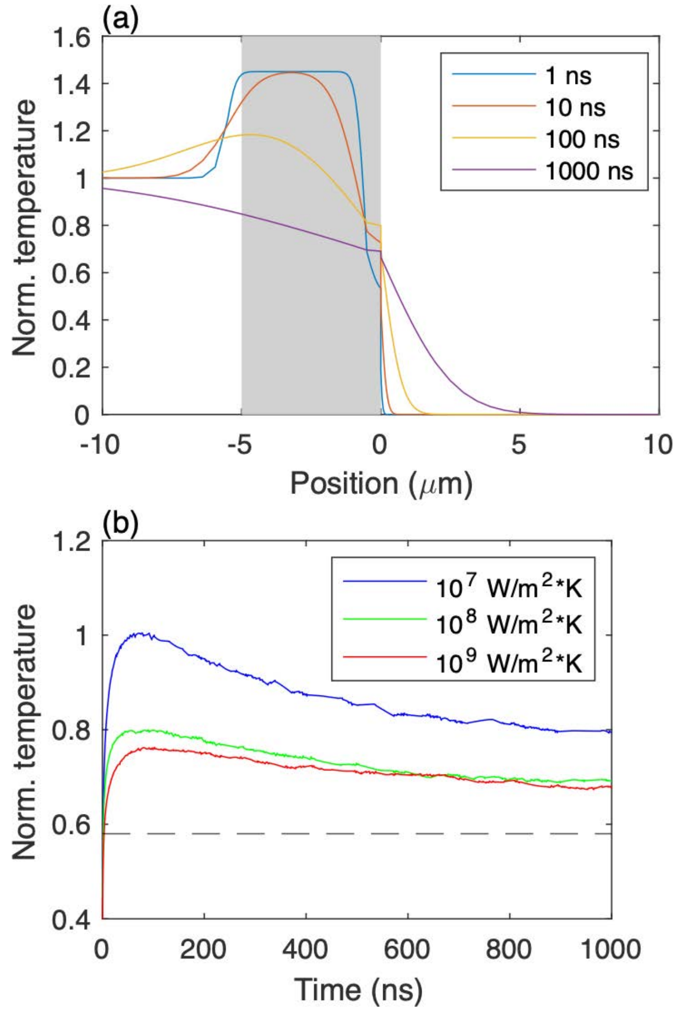
Novel study reveals new details on the impact of thermal interfaces in dynamic compression experiments

Temperature is an important, yet difficult, thermodynamic variable to measure in dynamic compression experiments. In particular for materials under dynamic compression, time-resolved temperature measurements are essential to understanding the physics influencing phenomena that range from equation of state to phase transition and chemical reaction.

In an "Editor's pick" in the *Journal of Applied Physics*, Tom Hartsfield (Neutron Science and Technology, P-23) and collaborators from the Nevada National Security Site and Sandia National Laboratories have shown that understanding the interface physics at play is even more important than precise temperature measurement when seeking to understand and predict the behavior of materials in such extreme environments.

While optical pyrometry is a general-purpose technique for measuring temperature from a radiant surface, that surface is often the interface between distinct materials with temperatures that vary spatially along the loading direction. As a result, interpreting dynamic temperature measurements remains a fundamental challenge.

Leveraging Los Alamos expertise in experiment design, diagnostic development, data analysis, and materials modeling, the researchers created and measured a series of varying thermal interfaces under shock compression. Comparing the results of these experiments to numerical analysis of the loading path and thermal diffusion at the measurement interface, the researchers discovered that shockwave interactions rapidly create and leave behind a complex local thermal profile. At the measurement point, material temperature subsequently evolves at longer characteristic timescales throughout the duration of the experiment. As a result, seemingly subtle changes in experiment geometry lead to very different temperature profiles that vary in time. This insight into the thermal and mechanical physics driving interface properties in dynamic compression experiments allowed the researchers to explain how the temperature of that interface relates to the fundamental bulk thermodynamic state that is used to improve the material models used in the Laboratory's hydrodynamics codes.



The initial (a) (normalized) temperature profile created by dynamic compression spatially varies across the measurement interface at 0 μm. Time-evolution of the temperature at that interface (b) shows how thermal diffusion produces interface temperatures that vary in comparison to the bulk thermodynamic material state (set to unity) of interest.

The Los Alamos portion of the research was funded by the Dynamic Materials Properties Campaign (LANL Program Manager Dana Dattelbaum, Project Leader Garry Maskaly) and supports the Laboratory's Stockpile Stewardship mission area and its Materials for the Future science pillar.

Reference: "Thermal interfaces in dynamic compression experiments," *Journal of Applied Physics* 128, (2020).

Researchers: Thomas Hartsfield (P-23); Brandon LaLone, Gerald Stevens, Lynn Veeser (Nevada National Security Site); Dan Dolan (Sandia National Laboratories).

Technical contact: Thomas Hartsfield

HeadsUP!

Mechanical material handling explained

Mechanical material handling (MMH) activities happen on a regular basis, whether that is moving a multimillion-dollar piece of unique equipment or moving something as common as office furniture.

P101-40, Mechanical Material Handling, is a new policy on how to conduct safe movements of loads and reduce worker injury. The policy covers work activities involving moving materials by various types of equipment that provide a mechanical advantage.

Examples of MMH activities include

- moving materials using a cart;
- transporting gas bottles, dewars, and/or liquid cylinders using a cart or dolly;
- using hand trucks, hydraulic lift tables, and pallet jacks; and
- moving unique configurations that require the involvement of a MMH coordinator.

P101-40 fills a significant gap within LANL safety and health policies as no institutional program specific to mechanical material handling has existed. As illustrated below, MMH fits squarely between manual material handling, forklifts, and hoisting and rigging.

P101-40 includes answers for important questions, such as:

- What is the difference between an ordinary vs. critical load activity? How do you determine the difference between the two?
- How and when should MMH equipment be inspected?
- What training is required for mechanical material handling?
- What hazards need to be considered prior to moving equipment safely?
- What are the safe work practices for common types of MMH equipment such as wheeled equipment, manual pallet jacks, and drum handling/lifting equipment?
- What are the safe work practices for handling and transporting materials such as palletized drums and compressed gas cylinders?

P101-40 was provisionally issued on July 22 and will become effective on January 22, 2021. For more information on MMH, please visit the Mechanical Material Handling website.

Mechanical Material Handling program lead:
Jerome Trujillo, OSH-ISH

Subject matter experts:

- Jerome Trujillo, OSH-ISH
- Tom Courtney, OSH-ISH
- Phil Romero, OSH-ISH

Celebrating service

Congratulations to the following Physics Division employees celebrating recent service anniversaries:

Steven Elliott, P-23	25 years
Takeyasu Ito, P-25	15 years
Tamsen Schurman, P-26	15 years
Cesar Da Silva, P-25	10 years
Dana Duke, P-23	10 years
John Dunn, P-24	10 years
Verena Geppert-Kleinrath, P-23	5 years
Xuan Li, P-25	5 years

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For past issues, see www.lanl.gov/org/ddste/aldps/physics/physics-flash-archive.php.

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